CLAIMS

What is claimed is:

1. A dry scrubbing system for treatment of effluent from an upstream effluent-generating process to remove scrubbable gas species therefrom, within an operating window of process conditions involving substantial variation in flow rate and/or concentration of the scrubbable gas species during operation of the system, said system comprising:

a first dry scrubbing material arranged for contact with said effluent, wherein said first dry scrubbing material is (i) effective under process conditions constituting a first operating regime within said operating window of process conditions to achieve at least a predetermined level of removal of the scrubbable gas species from the effluent, and (ii) less effective outside of the first operating regime within said operating window of process conditions to achieve at least the predetermined level of removal of the scrubbable gas species from the effluent;

a second dry scrubbing material arranged for contact with said effluent, wherein said second dry scrubbing material is (i) effective under process conditions constituting a second operating regime within said operating window of process conditions to achieve at least the predetermined level of removal of the scrubbable gas species from the effluent, and (ii) less effective outside of the second operating regime within said operating window of process conditions to achieve at least the predetermined level of removal of the scrubbable gas species from the effluent; and

wherein effluent from the upstream effluent-generating process is arranged to contact both of said first dry scrubbing material and said second dry scrubbing material, and said first

dry scrubbing material and said second dry scrubbing material together are effective to achieve at least said predetermined level of removal of the scrubbable gas species from the effluent, over the entire range of process conditions in said process operating window.

2. The system of claim 1, wherein the upstream effluent-generating process is conducted in a semiconductor manufacturing plant.

3. The system of claim 1, wherein the scrubbable gas species comprises at least one of hydrides, halides, acid gases and organometallic compounds.

4. The system of claim 1, wherein the scrubbable gas species comprises hydride gas species.

5. The system of claim 1, wherein the scrubbable gas species comprises phosphine.

6. The system of claim 1, wherein the scrubbable gas species comprises arsine.

7. The system of claim 1, wherein the scrubbable gas species comprises gaseous phosphorus.

8. The system of claim 1, wherein the first dry scrubbing material and the second dry scrubbing material are in a dry scrubbing vessel, in successive zones therein.

9. The system of claim 1, wherein the first dry scrubbing material and the second dry scrubbing material are interspersed with one another.

10. The system of claim 1, wherein the interspersed first dry scrubbing material and the second dry scrubbing material are in a dry scrubbing vessel.

11. The system of claim 1, wherein the first dry scrubbing material and the second dry scrubbing material are each independently selected from the group consisting of: (I) hydride scrubbing materials selected from the group consisting of copper carbonate, basic copper carbonate, copper oxide, copper hydroxide, copper sulfate, zinc oxide, nickel oxide, potassium hydroxide, magnesium hydroxide, potassium iodide, silver oxide, activated carbon, molecular sieve, alumina, and silica gel; and (II) acid gas scrubbing materials selected from the group consisting of copper carbonate, basic copper carbonate, copper hydroxide, copper sulfate, lithium hydroxide, potassium thiosulfate, sodium thiosulfate, iron oxide, basic zinc oxide, calcium hydroxide, manganese oxide, calcium oxide, activated carbon, aluminum silicate, molecular sieve, aluminum oxide, silica gel, and potassium hydroxide;

and wherein the first dry scrubbing material is different from the second dry scrubbing material.

12. The system of claim 1, wherein one of the first dry scrubbing material and the second dry scrubbing material comprises potassium hydroxide.

13. The system of claim 12, wherein said potassium hydroxide is impregnated on a support.

14. The system of claim 13, wherein said support comprises a material selected from the group consisting of molecular sieves, alumina, silica, carbon, macroreticulate polymers, and metal oxides.

15. The system of claim 13, wherein said support has a divided form.

16. The system of claim 15, wherein said support is in a particulate form.

17. The system of claim 1, wherein one of the first dry scrubbing material and the second dry scrubbing material comprises potassium hydroxide impregnated on a copper oxide/zinc oxide extrudate.

18. The system of claim 1, wherein the upstream effluent-generating process comprises a III-V semiconductor manufacturing process.

19. The system of claim 1, as joined in effluent-receiving relationship to an effluent-generating process.

20. The system of claim 19, comprising flow circuitry interconnecting the system and the effluent-generating process.

21. The system of claim 20, wherein the flow circuitry has a vacuum pump coupled thereto.

22. The system of claim 21, wherein the flow circuitry has a cold trap coupled thereto.

23. The system of claim 22, wherein the cold trap is downstream of the vacuum pump.

24. The system of claim 19, wherein the upstream effluent-generating process comprises a III-V semiconductor manufacturing process.

25. The system of claim 1, wherein the operating window of process conditions involves substantial variation in flow rate of the scrubbable gas species during operation of the system.

26. The system of claim 1, wherein the operating window of process conditions involves substantial variation in concentration of the scrubbable gas species during operation of the system.

27. The system of claim 1, wherein the operating window of process conditions involves substantial variation in flow rate and concentration of the scrubbable gas species during operation of the system.

28. The system of claim 1, wherein the first dry scrubbing material comprises a hydride-selective chemisorbent material, and the second dry scrubbing material comprises potassium hydroxide impregnated on a copper oxide/zinc oxide substrate.

29. The system of claim 1, further comprising a third dry scrubbing material arranged for contact with said effluent after said effluent has contacted said first dry scrubbing material and said second dry scrubbing material.

30. The system of claim 29, wherein the first dry scrubbing material comprises a hydride-selective chemisorbent material, the second dry scrubbing material comprises a gaseous phosphorus-selective chemisorbent material, and the third dry scrubbing material comprises a hydride-selective chemisorbent material.

31. The system of claim 1, wherein the first dry scrubbing material comprises a hydride-selective chemisorbent material, the second dry scrubbing material comprises a gaseous phosphorus-selective chemisorbent material.

32. A system for abating a gaseous phosphorus-containing effluent, comprising a dry scrubbing unit arranged for contact with said effluent, wherein said dry scrubbing unit comprises potassium hydroxide.

33. The system of claim 32, wherein the potassium hydroxide is impregnated on a support.

34. The system of claim 33, wherein the support comprises a material selected from the group consisting of molecular sieves, alumina, silica, carbon, macroreticulate polymers, and metal oxides.

35. The system of claim 33, wherein the support comprises metal oxide.

36. The system of claim 35, wherein the metal oxide comprises copper oxide and zinc oxide.

37. The system of claim 32, wherein the dry scrubbing unit comprises a dry scrubbing material chemisorptive for hydride gas.

38. The system of claim 37, wherein the hydride gas comprises phosphine.

39. The system of claim 32, wherein the effluent further comprises phosphine.

40. The system of claim 32, wherein the effluent derives from a semiconductor manufacturing facility.

41. The system of claim 32, wherein the effluent derives from a III-V process facility.

42. A method of abating gaseous phosphorus in an effluent including same, said method comprising contacting the effluent with potassium hydroxide.

43. The method of claim 42, wherein the potassium hydroxide is impregnated on a support.

44. The method of claim 43, wherein said support comprises a material selected from the group consisting of molecular sieves, alumina, silica, carbon, macroreticulate polymers, and metal oxides.

45. The method of claim 43, wherein said support has a divided form.

46. The method of claim 43, wherein said support is in a particulate form.

47. The method of claim 43, wherein the potassium hydroxide is impregnated on a copper oxide/zinc oxide substrate.

48. The method of claim 42, wherein the effluent derives from a semiconductor manufacturing process.

49. The method of claim 42, wherein the effluent derives from a III-V semiconductor manufacturing process.

50. A method of treatment of effluent from an upstream effluent-generating process to remove scrubbable gas species therefrom, within an operating window of process conditions involving substantial variation in flow rate and/or concentration of the scrubbable gas species, said method comprising:

contacting said effluent with a first dry scrubbing material, wherein said first dry scrubbing material is (i) effective under process conditions constituting a first operating regime within said operating window of process conditions to achieve at least a predetermined level of removal of the scrubbable gas species from the effluent, and (ii) less effective outside of the first operating regime within said operating window of process conditions to achieve at least the predetermined level of removal of the scrubbable gas species from the effluent;

contacting said effluent with a second dry scrubbing material, wherein said second dry scrubbing material is (i) effective under process conditions constituting a second operating regime within said operating window of process conditions to achieve at least the predetermined level of removal of the scrubbable gas species from the effluent, and (ii) less effective outside of the second operating regime within said operating window of process conditions to achieve at least the predetermined level of removal of the scrubbable gas species from the effluent; and

wherein said effluent contacts both of said first dry scrubbing material and said second dry scrubbing material, and said first dry scrubbing material and said second dry scrubbing material together are effective to achieve at least said predetermined level of removal of the

scrubbable gas species from the effluent, over the entire range of process conditions in said process operating window.

51. The method of claim 50, wherein the upstream effluent-generating process is conducted in a semiconductor manufacturing plant.

52. The method of claim 50, wherein the scrubbable gas species comprises at least one of hydrides, halides, acid gases and organometallic compounds.

53. The method of claim 50, wherein the scrubbable gas species comprises hydride gas species.

54. The method of claim 50, wherein the scrubbable gas species comprises phosphine.

55. The method of claim 50, wherein the scrubbable gas species comprises arsine.

56. The method of claim 50, wherein the scrubbable gas species comprises gaseous phosphorus.

57. The method of claim 50, wherein the first dry scrubbing material and the second dry scrubbing material are in a dry scrubbing vessel, in successive zones therein.

58. The method of claim 50, wherein the first dry scrubbing material and the second dry scrubbing material are interspersed with one another.

59. The method of claim 58, wherein the interspersed first dry scrubbing material and the second dry scrubbing material are in a dry scrubbing vessel.

60. The method of claim 50, wherein the first dry scrubbing material and the second dry scrubbing material are each independently selected from the group consisting of: (I) hydride scrubbing materials selected from the group consisting of copper carbonate, basic copper carbonate, copper oxide, copper hydroxide, copper sulfate, zinc oxide, nickel oxide, potassium hydroxide, magnesium hydroxide, potassium iodide, silver oxide, activated carbon, molecular sieve, alumina, and silica gel; and (II) acid gas scrubbing materials selected from the group consisting of copper carbonate, basic copper carbonate, copper hydroxide, copper sulfate, lithium hydroxide, potassium thiosulfate, sodium thiosulfate, iron oxide, basic zinc oxide, calcium hydroxide, manganese oxide, calcium oxide, activated carbon, aluminum silicate, molecular sieve, aluminum oxide, silica gel, and potassium hydroxide;

and wherein the first dry scrubbing material is different from the second dry scrubbing material.

61. The method of claim 50, wherein one of the first dry scrubbing material and the second dry scrubbing material comprises potassium hydroxide.

62. The method of claim 61, wherein said potassium hydroxide is impregnated on a support.

63. The method of claim 62, wherein said support comprises a material selected from the group consisting of molecular sieves, alumina, silica, carbon, macroreticulate polymers, and metal oxides.

64. The method of claim 62, wherein said support has a divided form.

65. The method of claim 62, wherein said support is in a particulate form.

66. The method of claim 50, wherein one of the first dry scrubbing material and the second dry scrubbing material comprises potassium hydroxide impregnated on a copper oxide/zinc oxide substrate.

67. The method of claim 50, wherein the upstream effluent-generating process comprises a III-V semiconductor manufacturing process.

68. The method of claim 50, wherein flow circuitry interconnects the effluent-generating process and a dry scrubbing vessel containing the first dry scrubbing material and the second dry scrubbing material.

69. The method of claim 68, further comprising vacuum pumping the effluent from the effluent-generating process to the dry scrubbing vessel.

70. The method of claim 69, further comprising flowing the effluent from through a cold trap prior to its entering the dry scrubber vessel.

71. The method of claim 50, wherein the operating window of process conditions involves substantial variation in flow rate of the scrubbable gas species.

72. The method of claim 50, wherein the operating window of process conditions involves substantial variation in concentration of the scrubbable gas species.

73. The method of claim 50, wherein the operating window of process conditions involves substantial variation in flow rate and concentration of the scrubbable gas species.

74. The method of claim 50, wherein the first dry scrubbing material comprises a hydride-selective chemisorbent material, and the second dry scrubbing material comprises potassium hydroxide impregnated on a copper oxide/zinc oxide substrate.

75. The method of claim 50, further comprising contacting the effluent with a third dry scrubbing material after said effluent has contacted said first dry scrubbing material and said second dry scrubbing material.

76. The method of claim 75, wherein the first dry scrubbing material comprises a hydride-selective chemisorbent material, the second dry scrubbing material comprises a gaseous phosphorus-selective chemisorbent material, and the third dry scrubbing material comprises a hydride-selective chemisorbent material.

77. The method of claim 50, wherein the first dry scrubbing material comprises a hydride-selective chemisorbent material, the second dry scrubbing material comprises a gaseous phosphorus-selective chemisorbent material.

78. A method of treating effluent to provide a predetermined level of removal of at least one undesired species from the effluent, wherein the undesired species has a variable presence, concentration and/or flow rate constituting differing regimes of effluent treatment

operation, said method comprising contacting the effluent with at least two different sorptive media for removal of said at least one undesired species, wherein each sorptive medium has differing removal efficiency for undesired species in at least two of said regimes of effluent treatment operation, and wherein said different sorptive media in combination provide a predetermined removal efficiency for said undesired species.